UNITED
NATIONS

TD

United Nations Conference
on Trade and Development

Distr.
GENERAL

TD/B/CN.1/16
27 September 1993

Original: ENGLISH

TRADE AND DEVELOPMENT BOARD
Standing Committee on Commodities
Second session
Geneva, 1 November 1993
Item 7 of the provisional agenda

FOSTERING SUSTAINABLE DEVELOPMENT IN THE COMMODITY FIELD: ANALYSIS OF NATIONAL EXPERIENCES IN THE MANAGEMENT OF NATURAL RESOURCES WITH REGARD TO COMMODITY PRODUCTION

Mineral resources and sustainable development

Report by the UNCTAD secretariat*/

*/ For the secretariat report under this agenda item dealing with agricultural commodities, see TD/B/CN.1/15

GE.93-53555

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SUMMARY AND CONCLUSIONS

1. This report considers the major policy areas which mineral economies, especially non-fuel mineral economies, need to address at the national level in order to foster a process of sustainable development.

2. Sustainable development is commonly defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs".[1] While there is general agreement that sustainability includes not only environmental components, but also economic, social and even political ones, the sustainability of development based on the exploitation of mineral resources is often linked primarily to the issue of the depletion of those resources, as well as to the potential environmentally damaging effects of their exploitation.

3. Mineral resources - unlike agricultural resources - are indeed not renewable; the exploitation of mineral resources for commodity production entails the eventual depletion of these resources. In the context of sustainable development, the depletion of natural assets is a cause for concern. In the case of mineral resources, however, new geological discoveries continue to add to world mineral reserves; moreover, many mineral commodities, especially metallic mineral products, can be recovered after use and recycled. For these reasons, depletion *per se* does not appears as the main concern at the global level in the case of non-fuel mineral resources (although it may be, of course, a major concern for individual countries).

4. Nevertheless, in order to make a positive contribution to sustainable development, it is essential that depleting mineral assets be used to generate new wealth which, in the form of useful lasting capital, can benefit present and future generations. Here a paradox presents itself. The economic performance of mineral economies tends to be below that of non-mineral economies. Mineral wealth seems to engender poor economic performance. A weak and deteriorating economy cannot provide support to the process of sustainable development.

5. The onus for ensuring that mineral assets are used to generate new wealth lies largely with government: first, to establish an adequate legal, fiscal and regulatory framework for mineral production; secondly and most important, to capture the surplus or "rent" which arises from mineral-sector activity and to oversee the absorption of this mineral rent for the good of the economy as a whole. When the mineral sector is large relative to the rest of the economy - as is the case for a number of developing countries - the ability of government to manage mineral revenue becomes a critical factor for the achievement of sustainable development.

6. In mineral economies, however, the management of mineral revenue appears to be highly problematic. Many of these economies experience a condition, known to economists as "Dutch disease"[2], whereby the inflow of mineral wealth causes movements in relative prices and the exchange rate which have a pervasive negative impact on other sectors of the economy, including agriculture and manufacturing. Dutch disease can halt and even reverse the process of sustainable development because it allows mineral wealth to dissipate and because

it can obstruct the competitive diversification of the economy. This condition constitutes a major challenge for most minerals economies and can be addressed only through effective macroeconomic management.

7. In addition to macroeconomic management, government has an important role to play in the organization of mineral production. The primary objective in this case is to ensure, by means of an appropriate legislative and regulatory framework, that the nation's mineral resources are exploited with a maximum of economic and environmental efficiency. Given an appropriate framework, the responsibility for efficient mineral production can be transferred to the private entrepreneur. In a number of countries, however, the government, through ownership of the mining enterprise, acts both as entrepreneur and regulator. This situation may create conflicts of responsibility. Such conflicts can detract from the efficiency of the mineral enterprise. The financial autonomy of the enterprise may become difficult to maintain with adverse effects on investment. In some cases, the mineral enterprise can be decapitalized to the extent that environmental liabilities, *inter alia*, are neglected. The managerial autonomy of the enterprise and the fiscal regime under which it operates are thus crucial elements in securing a maximum contribution of State mineral companies to sustainable development.

8. Another important area for government action is mineral resource information. In order to promote investment in a country's mineral resources, a comprehensive geological survey is essential. Mineral resource information, including soil and hydrological information, is also necessary for planning various aspects of the sustainable development of the economy, for example, in the optimal location of physical infrastructure. Often, despite this need, public investment in mineral resource information and related earth-science education is accorded low priority. This is the case particularly in developing countries because the opportunity cost of such investment is typically very high.

9. In order to maintain a forward momentum in the process of sustainable development, the governments of mineral economies - or any country contemplating the large-scale exploitation of its mineral resources - will need to fix and pursue policy objectives at least in the areas referred to above. The specific policies to be pursued will differ from country to country, depending, *inter alia*, on the relative importance or potential of the mineral sector in the national economy, and on the country's priorities and capacities. For the purpose of designing suitable policies, and in view of the obsevations made above, it is suggested that consideration be given to the following broad objectives and approaches:

- The macroeconomic management of mineral economies calls for special attention, particularly with regard to the exchange rate and sectoral adjustment policies. Mineral booms will tend to cause premature resource movements out of agriculture and stimulate capital-intensive and possibly uncompetitive manufacturing activity. For most developing mineral economies, a balanced - but pragmatic and flexible - macroeconomic approach is required. It would need to be based on a staged transition towards well-defined, long-term goals which would include competitive diversification. The absorption of mineral rent will need to be carefully controlled, possibly through the institution of a mineral revenue fund.

- At the enterprise level, the organization of mineral production needs to be efficient in order to maximize the contribution of the mineral sector to economic growth and sustainable development. To that end, private enterprise should be encouraged. Government should consider limiting its operational role in mineral production to situations where private enterprise is unable or unwilling to operate; existing State-owned enterprises should be given the managerial and financial autonomy necessary to address accumulating economic and environmental liabilities; the reform of State-owned enterprises should be considered against the background of other policy options, notably full or partial privatization. Government should, in any case, have an effective fiscal policy with a view to capturing mineral rents, and consider for this purpose a progressive tax on profits with allowances for environment-related costs.

- The collection and use of mineral resource information needs to be organized, and if necessary expanded, so as to better serve the planning and management of other aspects of the national economy. This may require a more integrated and inter-disciplinary approach to development and regional planning by various departments of government, including the department responsible for the national geological survey.

10. The achievement of sustainable development will depend largely on the capacity of government in mineral economies to design and implement policies in the above areas. In a number of cases, however, mineral economies are low-income or least developed countries; the limited political, financial and technical capacities of these countries will need to be supplemented with external assistance in order to make progress in dealing with the more complex and long-term policy issues identified above.

INTRODUCTION

11. Sustainable development is a complex process calling for simultaneous global progress in a variety of dimensions - economic, environmental, human, political and technological. A central feature of this process is the interaction between economic activity and the natural environment. Here, the natural environment plays a dual role: as a resource base for a range of commodities and services, and as a receptacle or sink for the residues of processing and consumption activity. Effective performance of this dual role - a necessary condition for sustainable development - requires a robust ecological equilibrium at both the local and global levels. The preservation of this equilibrium requires, in turn, that economic activity be managed and its consequences controlled so as to avoid excessive depletion and pollution of the natural resource base.

12. In effect, much of mankind's economic activity centres on the exploitation of natural resources. They make an important and irreplaceable contribution to human welfare, providing food, fuel and shelter. Although the possession of

natural resources is not a necessary condition for national economic development - given the possibility of international trade to exchange goods and services - most countries would view a good natural resource endowment as a positive element that can help to further the nation's welfare. This is particularly true of most developing countries - and of a few developed countries - where economic activity centres largely on the production of primary commodities.

13. All primary products, by definition, are either themselves natural material resources, as is the case with minerals, or are derived directly from natural resources. Forestry products and agricultural crops depend on soil, the hydrologic cycle and sunlight; animals depend mainly on plant life. Natural material resources are often classified as renewable or non-renewable; but all material resources, both renewable and non-renewable, are depletable. For biotic resources, depletion entails reduced stocks and populations of plants and animals, leading to a reduction in the sustainable flow of ecosystem services. While the original level of the flow may be restored through investment (or reduced consumption), restoration can also prove to be impossible. Because they are finite, and non-renewable in terms of the human time scale, the idea of depletion is perhaps more readily associated with mineral resources.

14. These latter resources and in particular the non-fuel minerals, both metallic and non-metallic, are the subject of this report. This group of minerals has received less attention in the debate on sustainable development than the fuel or energy minerals. Non-fuel minerals nevertheless constitute an important group of more than 50 commodities which together account for around 16 per cent of world trade in primary products, more than the combined shares of animal, forestry and fishery products.[3] Moreover, economic activity in a number of developing countries - and some developed countries - is largely dependent on the production of these minerals. How this mineral production activity is managed and its impact on economic growth and sustainable development are the focus of the report.

15. Because they are non-renewable, it is especially important that the exploitation (i.e. the depletion) of mineral resources be managed in a purposeful manner which fosters the process of sustainable development. At the global level, non-renewability *per se* is not a major concern in this regard. New geological discoveries are continually being made, and although such discoveries only affect the time span over which depletion can continue, that time span is generally increasing while only a relatively shallow part of the earth's crust is being explored. Moreover, many minerals, once exploited and "consumed" as commodities, can be recycled for further use, sometimes continually; thus, the substance of such minerals is not depleted in any final sense. At the national level, however, depletion can become a reality, especially where the physical resource base is very limited, as in small island economies. For all countries, the exploitation of mineral resources in a context of sustainable development implies that the resources must be converted, with a maximum of economic and environmental efficiency, into useful capital which will benefit present and future generations.[4]

16. The business of mineral production is typically large-scale and long-term. It can start with the search for mineral resources and finish, many decades later, with the depletion of mineral reserves and - ideally - the rehabilitation

of the mining site. The business may also include downstream processing activities. It will often involve the construction of extensive attendant infrastructure and transport facilities. The impact of all this activity on the national economy and the natural environment is highly varied and complex. This report identifies three broad areas of interface between mineral sector activity and sustainable development where the management of policy issues seems to warrant more attention, with a view to achieving greater economic and environmental efficiency. The first area concerns macroeconomic management, which is an especially important issue for mineral economies; the second area covers the organization of production and, in particular, the role of the State; and the third area concerns the use of information, which is - or should be - a major element in the management of mineral resources.

17. These three broad areas each involve a large number of technical and policy issues which cannot all be addressed in a short report. The approach adopted here is therefore highly selective. It has nevertheless been guided by interaction over the past few years with experts from a number of mineral-producing countries and development organizations, in the context of an UNCTAD research project (MINDEV) examining the role of the mineral sector in economic development.[5] Given the brevity of the present report, the views expressed below are a synthesis of this interaction rather than an account of varied national experiences. The aim is to point to those issues which fall within the ambit of national government and are foremost in the context of sustainable development.

I. MANAGING DEVELOPMENT IN MINERAL ECONOMIES

18. Developing mineral economies - *i.e.* developing countries in which the mineral sector accounts for an above-average share of gross domestic product and of exports - appear to have a special difficulty in sustaining economic growth over the long-term. Economies that rely heavily on exports of non-fuel minerals are especially poor performers: of 20 countries that can be classified in this group, 17 have below-average growth and only one country (Botswana) has achieved a noticeably high rate of growth; this contrasts with the much superior growth performance of countries which export manufactures and with the more mixed but still relatively better performance of agricultural economies (see box 1).

19. This situation is counter-intuitive since the mineral wealth of these countries should normally give them a comparative advantage, other things being equal. Many mineral economies neverthless figure among the least developed countries: not only has their economic performance been poor but their basic level of development has remained very low and in some cases continues to deteriorate. Some other developing countries may wish to diversify their economies by exploiting their mineral resources: is this advisable? Can the exploitation of mineral resources become an obstacle to economic growth and sustainable development? These questions are examined below together with the policies needed to ensure that mineral wealth makes a positive contribution to sustainable development.

BOX 1.

ECONOMIC GROWTH ELUDES MANY MINERALS ECONOMIES

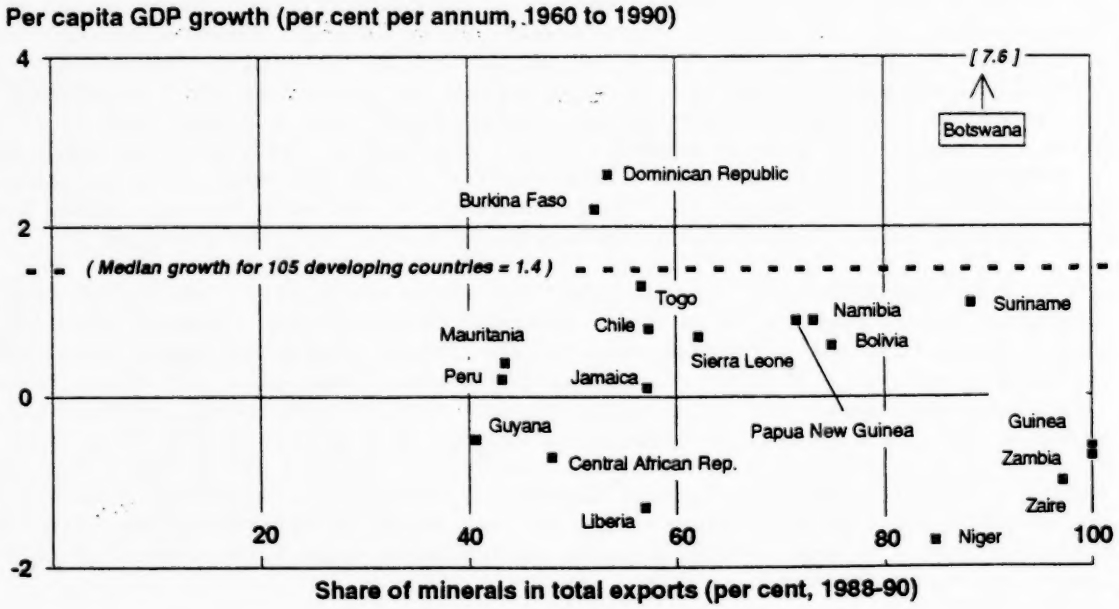
In order to compare different groups of countries, a sample of 105 developing countries was divided into four groups according to export specialization as measured for the period 1988-1990. Countries were classified as follows: first, all countries for which manufactures accounted for 50 per cent or more of total exports were classified as exporters of manufactures; the remaining countries were classified either as exporters of agriculture or fuels or non-fuel minerals according to the commodity grouping which had the largest share of total exports. Growth performance for each country was measured as the average annual rate of change of real GDP *per capita* over the period 1960 to 1990; for this period, the median rate for all 105 countries was 1.4 per cent per year.

The number of countries in each group and their distribution above or below the median rate of growth was as follows:

	Manufactures	Agriculture	Fuels	Non-fuels	Total
Above	21	14	14	3	52
Below	5	25	6	17	53
Total	26	39	20	20	105

Note that several of the 14 countries classified above as "fuel exporters" with above-average growth had in fact quite diversified economies (notably Ecuador, Egypt, Indonesia, Mexico, Seychelles, Syrian Arab Republic, and Trinidad and Tobago). The diversified nature of these economies, rather than their export concentration, may largely explain their superior growth performance and account for the relatively high number of countries appearing in this category.

The 20 non-fuel mineral exporting countries are shown below in relation to growth performance and mineral export dependency:



A. The impact of resource revenues on the national economy

20. The revenue generated through the exploitation of mineral resources can be substantial and act as a powerful catalyst for development. It it also has the potential to increase dependence, cause inflation and distort the national economy. These negative impacts result from a condition known to economists as "Dutch disease".[6] The genesis and development of this condition, which eventually pervades and deteriorates the whole economy, can be summarized in the following stylized facts:

- The cycle starts when the mineral sector undergoes a rapid development or boom, either through new resource discovery and new mining projects, or through increases in international mineral prices, or both. Because the mineral sector has few backward or forward linkages to other industries, the main impact of the boom is transmitted to the economy through the increase in export revenue and the resulting inflow of foreign exchange.

- As this revenue flow increases, the exchange rate tends to appreciate and money supply grows. This leads to increased imports and to higher prices in the non-tradeables sector, while in the tradeables sector - mainly agriculture and manufactures - both income and profits decrease because of loss of competitiveness and higher domestic costs.

- Government income benefits from the boom, either directly through State ownership or through the taxation of mining and processing enterprises. This fiscal linkage - the capture of mineral resource revenues and their subsequent redistribution by central government - reinforces the effect of the boom. The government will be under pressure to increase both current expenditure and investment, and possibly to lower taxes and the prices of public services. The increased public expenditure is likely to fuel inflation, in particular if public investment projects, as is often the case, encounter supply bottlenecks. It also encourages rent-seeking activity, which dissipates revenue without generating new wealth.

- As the situation deteriorates, the government grants protection from lower priced imports to import-substituting industries in the tradeables sector. If protection is given across the board, it allows the creation or continuation of industries that would never survive unprotected; if applied more selectively, and in particular if given in the form of non-tariff measures, protection leads to the creation of local monopolies. Although justified initially as a temporary measure, protection often becomes a permanent feature of the economy.

- As soon as the boom is over, revenue from the mineral sector declines abruptly and a fiscal deficit develops. At this stage, the government resorts to foreign borrowing and the national debt and debt service grows. The government also attempts to reduce the deficit by delaying investment in State-owned enterprises (which become decapitalized) and by raising taxes on private mining companies. The deficit helps to accelerate inflation. Investment decreases in all sectors, partly because of uncertainty due to the higher inflation rate and partly because of the reduced surplus in the mineral sector and exhaustion of "easy" opportunities for import substitution.

- The last stage is characterized by: a decapitalized State mineral sector or a discouraged private mining sector; a non-mineral export sector that has been much reduced, including a prematurely shrunken agricultural sector; an import-competing sector with low capacity utilization and low profitability; the depletion of international reserves; a high debt-service burden; and hyperinflation. At this stage, austerity programmes are imposed, if politically feasible.

- The cycle will eventually start again, given a new increase in mineral export revenue, but the national economy will be further weakened with each successive cycle and over the longer term may actually contract.

21. Nearly all mineral economies have suffered from at least some of the severe economic dislocations described above. The most noted cases have perhaps been petroleum-exporting countries but the non-fuel mineral economies have also been seriously affected.[7] Dutch disease retards the process of sustainable development in at least two ways: first, it allows mineral wealth to dissipate, without constituting replacement capital for future generations; and, secondly, it severely weakens the national economy and reduces a country's capacity to diversify and to invest in sustainable production and technology. For mineral economies, therefore, the control of Dutch disease is a prerequisite to sustainable development.

B. A reserve fund for mineral resource revenues

22. Given the prominence in mineral economies of the fiscal link, the redistribution of resource revenue plays a major role in propagating Dutch disease. Among other influences, the direct use of this revenue by government tends to reinforce the inflationary impact of a mineral boom. An alternative to direct revenue use is a mechanism whereby resource rents, once captured, are largely isolated from the government's general revenue fund, and their entry into the economy is controlled. This mechanism can take the form of a mineral-revenue reserve fund which provides central government with a regular stream of income. As such, it would serve to stabilize receipts of, and expenditure from, the general revenue fund especially during mineral booms and their aftermath. Moreover, if the fund were constituted as a permanent feature of the economy, it would also serve one of the aims of sustainable development by preserving the proceeds from mineral wealth for future generations.

23. Among developing non-fuel mineral economies, two of the more successful countries - in terms of recent economic performance - have instituted some form of mineral reserve fund. In Chile, a mineral stabilization fund was established in 1985. This fund works by progressively accumulating revenue from copper when the market price moves above a predetermined base level; this fund is frozen until the price falls below the base level, at which point it is gradually released. In addition to its stabilizing effect, the fund prevents political pressure from determining the use of mineral revenues, this latter feature having been facilitated in Chile by the greater degree of autonomy recently granted to the cental bank. In Botswana, the Government has followed a policy of planned, stable development expenditures since mineral revenue (mainly from diamonds)

started booming in the early 1970s. Increases in mineral revenue above projected levels have generally been treated as temporary windfalls; this surplus has been used to augment international reserves and not to increase domestic investment above planned levels. Such reserves helped, *inter alia*, to finance the government's drought relief programme during a prolonged period of rainfall failure (1982-1988) and allowed the agricultural sector - accounting for 80 per cent of the country's population - to avoid a serious and premature contraction.[8] In both these countries, the main aim has been to stabilize the trajectory of the economy through the mineral cycle. In both cases this policy has helped to attenuate the negative impacts of Dutch disease and has contributed to stable growth. Since stable economic growth contributes to the process of sustainable development, a mineral-revenue reserve fund could be a useful and even necessary policy instrument for mineral economies seeking to further that process.

24. If a reserve fund is not established as a permanent feature of the State and proper provision made for its administration as a trust fund, there is a risk that the fund and the income from it will be used for other purposes or eventually disappear altogether (as happened, for example, to the Zambian mineral stabilization fund which was established in the mid-1960s and abandoned in 1972). In mineral economies, the process of sustainable development could be better supported by a permanent fund that would accummulate and hold in trust some portion of national mineral revenues. Such a trust fund, which could be protected under the national constitution from misappropriation by political and other interest groups, would extend the benefits of resource revenue over several generations or in perpetuity. Moreover, it could be used to provide an additional source of budgetary income or to achieve other specific objectives, including, for example, protection of the natural environment. Depending on how the fund is structured and how well it is administered, the earnings from the fund's capital could themselves replace the income from the depleting mineral resource.

25. The few existing examples of natural-resource trust funds may be found in developed countries: for example, the Alberta Heritage Savings Trust Fund in Canada and the Alaska Permanent Fund in the United States of America.[9] A permanent trust fund that effectively isolates a large portion of resource revenues may be easier to establish in a high-income developed country than in a developing country where average *per capita* income is very low (as is the case for most mineral economies) and popular pressure for immediate distribution is likely to be intense. Nevertheless, it is precisely the highly underdeveloped nature of many mineral economies that makes the efficient absorption of windfall revenue very difficult. This difficulty thus provides an additional argument for a fund which would hold a portion of mineral revenues in reserve, ideally as a permanent trust fund to support the process of sustainable development.

C. Diversification in developing mineral economies

26. In developing countries, mineral production that is large-scale and export-oriented tends to function as an enclave in the national economy with few backward or forward linkages to other domestic industries. The main and perhaps the only backward link is with the energy sector. Often there is no significant

forward link, apart from the metal refining industry. These industries are capital-intensive with low labour requirements; moreover, in most developing countries the capital must be imported. Thus, the exploitation of mineral resources, in contrast to agricultural and manufacturing activity, typically provides little direct stimulus to the development of other sectors of the national economy. Further, as seen above, the impact of mineral revenues can deepen the dependency of the economy on the mineral sector and at the same time make diversification difficult to achieve.

27. Given the damage that can be caused by Dutch disease, as mentioned earlier, the management of competitive diversification is more difficult in developing mineral economies than in agricultural economies. It also places a large burden on the capacity of government to conduct a pragmatic and flexible approach to both exchange rate and trade policies.[10] Mineral-driven shifts in the exchange rate need to be limited in order to safeguard the competitive diversification of the non-mining tradeables sector; exchange rate appreciation on a large scale can otherwise permanently damage productive capacity and leave the economy too weak to respond to an eventual fall in mineral prices. The macroeconomic policy approach is thus orthodox but not doctrinaire: in addition to the use of a mineral revenue stabilization fund, it involves incremental adjustment and staged transition rather than rapid liberalization.

28. Specific policies for individual mineral economies will differ depending on country size and level of development. Larger mid-income countries which already have a sizeable but uncompetitive manufacturing sector will need to stage a gradual phasing out of import quotas, as well as sector-specific industrial incentives, and a scaling down of tariff barriers. State-owned manufacturing firms will need to be privatized. In low-income countries, a long-term incremental depreciation of the exchange rate could allow both export expansion and import substitution without requiring elaborate administrative measures to encourage new investment. Wage rates may also need to be adjusted in order to discourage rent-seeking activity, to control migration from rural areas and to encourage peasant farmers to expand into commercial agriculture.

29. The competitive diversification of developing mineral economies will create a more stable and more viable economic structure in these countries as compared to a structure that is heavily dependent on mineral production. The promotion of competitive activity outside of the mineral sector advances the process of sustainable development by establishing substitutes for the depleting mineral asset. The challenge for developing mineral economies is to mute the impact of Dutch disease so that competitive diversification becomes established. This creates an enabling environment for sustainable development.

II. THE ORGANIZATION OF MINERAL PRODUCTION

30. The exploitation of mineral resources can have a diverse and sometimes extensive impact on the economic, social and natural environments. In the socio-economic sphere, for example, large-scale mineral production can generate

significant new investment and employment opportunities, including the creation of local ancillary industries. The natural environment can be affected through the presence of mining infrastructure and the use of inputs such as land, fuel and water; by-products and wastes from mineral processing and refining can cause pollution of the environment.

31. Public awareness of these various impacts is growing. As a result, many countries have established legislation and controls to regulate and monitor mineral production activity. Entrepreneurs are increasingly required to undertake detailed impact assessment studies before mineral exploitation can begin; such studies help to anticipate and, sometimes, to avert the negative effects of mineral production on the natural habitat and on human settlements. New technology is available to make mineral production and processing cleaner as well as more efficient. All these factors help to create an enabling framework for the sound management of mineral resources. Nevertheless, the achievement of sustainable mineral development ultimately depends on the motivation and capacity of producers to organize production to that end.

A. State ownership and economic efficiency

32. A major feature of world mineral production is the large extent of State participation. Table 1 provides information on non-fuel mineral production and ownership structure for 38 countries which together accounted for nearly 90 per cent of world output in 1990. In 16 countries, accounting together for 35 per cent of world output, the business of mineral production was undertaken wholly or largely by the State. In several other countries - Brazil, Sweden and Guinea, for example - the State had a controlling interest in a significant part of the industry. State participation is particularly evident among developing countries: the State controlled 70 per cent of non-fuel mineral output in developing Africa, 56 per cent in developing America, and 33 per cent in developing Asia.[11] State control of mineral production also exists, to a lesser extent, in some developed countries, especially in Europe.

33. The issue of ownership of mineral sector enterprises is important inasmuch as it may determine the criteria adopted for measuring corporate performance. These criteria may conflict with the achievement of sustainable development, even when they are ostensibly aimed at the public good. An enterprise which is wholly controlled by the State nearly always pursues a set of goals which goes beyond the maximization of profits, the objective characteristic of private enterprise. For example, the enterprise may pursue additional goals set by Government in the fields of employment, income distribution and regional development. While such objectives in themselves may be compatible with the process of sustainable development, their inclusion at the working level of the enterprise can seriously compromise economic efficiency in terms of productivity and profits, and eventually undermine the longer-term ability of the enterprise to maintain the various goals set for it by Government. This is less likely to happen when the enterprise is controlled by a mix of public and private interests since the latter will be concerned mainly with the activities of the enterprise itself (for an example of such an enterprise, see box 2). There are, moreover, some successful enterprises which are wholly State-owned, notable examples being the

Table 1. Non-fuel mineral production and type of ownership, by country, 1990

	Mineral production (see note 1)		Type of ownership (see note 2)		Mineral production (see note 1)		Type of ownership (see note 2)
	US$ million	Share in world (%)			US$ million	Share in world (%)	
20 largest producing countries				Other mineral-dependent developing countries and territories			
USSR (former)	20,135	15.90	State	Papua New Guinea	802	0.63	Private
United States	16,630	13.13	Private	Guinea	524	0.41	Mixed
South Africa	12,675	10.01	Private	Zimbabwe	455	0.36	Private
Australia	9,867	7.79	Private	Mongolia	399	0.32	State
Canada	9,806	7.74	Private	New Caledonia	346	0.27	State
China	9,544	7.54	State	Jordan	321	0.25	State
Brazil	5,769	4.56	Mixed	Bolivia	295	0.23	Mixed
Poland	4,949	3.91	State	Jamaica	249	0.20	Mixed
Chile	4,173	3.30	State	Mauritania	222	0.17	State
Mexico	2,345	1.85	Private	Namibia	166	0.13	Private
Peru	1,759	1.39	Private	Dominican Republic	157	0.12	State
Botswana	1,671	1.32	Private	Sierra Leone	132	0.10	Private
India	1,612	1.27	State	Togo	113	0.09	State
Zaire	1,482	1.17	State	Liberia	105	0.08	State
Zambia	1,184	0.93	State	Suriname	75	0.06	Private
Sweden	1,029	0.81	Mixed	Guyana	56	0.04	State
Morocco	947	0.75	State	Fiji	51	0.04	Private
Germany (former FRG)	896	0.71	Private	Burkina Faso	43	0.03	Mixed
Philippines	846	0.67	Private	Total, above countries	112,653	88.95	- -
Spain	825	0.65	Private	WORLD TOTAL	126,645	100.00	- -

Notes: (1) Mineral production covers some 45 non-fuel, metallic and non-metallic mineral commodities valued at their international market price or export unit value.

(2) Type of ownership is defined as follows: "state" means that 60 per cent or more of output is controlled by Government; "private" means control is 60 per cent or more in the hands of private interests, whether domestic or foreign; and "mixed" means that control is approximately equally divided between Government and private interests.

Source: UNCTAD secretariat, Geneva; and Raw Materials Group, Stockholm, Sweden.

Chilean Copper Corporation (CODELCO) and the Moroccan *Office Chérifien des Phosphates* (OCP). For all these reasons, the extent to which economic efficiency is affected by ownership will tend to vary from one country to another.[12]

34. One area in which private enterprise tends to perform better is labour productivity. The data given in table 2 provide a comparative example for selected copper producing countries in 1988.[13] While labour productivity varies among countries by a factor of 1 to 8, the data show that it is clearly higher in the United States, where production is in the hands of private enterprise, than in the other three countries where production is wholly or largely controlled by the State. One reason for this disparity is that State-owned companies find it more difficult to maintain flexibility in the labour force because of the political and social consequences which might ensue. In some cases, however, a deliberate economic decision to adopt a given level of labour intensity may reflect the relative cost of labour and capital.

Table 2

	Mine production (thousand tons)	Estimated cost of production (US cents per pound)	Productivity (tons per man/year)
Country			
USA	1438	53	60
Chile	1451	40	43
Zaire	471	76	13
Zambia	450	95	7.5

35. A major aim of State participation is to capture the resource rent or surplus which accrues from mineral production after allowing for the cost of production. In 1988, for example, when the price of copper averaged US$ 1.18 per pound, the rent earned by the State enterprise in Chile would have been approximately 1,720 dollars per ton of copper produced, in Zaire 925 dollars, and in Zambia 505 dollars, based on the production costs given in the table. While the management of mineral rents and their effective contribution to sustainable development is problematic (as discussed in the preceding chapter), these rents can nevertheless represent a very significant proportion of total government revenue. In a mineral-dependent developing economy especially, Government comes to rely heavily on a regular stream of income from the State enterprise. To continue to provide this in times of falling or fluctuating prices, the State enterprise may be obliged to postpone capital investment, including that for environmental protection, or to exploit only or mostly the highest grades - i.e. the most valuable part - of the mineral deposit.

BOX 2.

**COMPANHIA VALE DO RIO DOCE (CVRD):
BRAZIL'S LARGEST ENTERPRISE IS A MIXED PRIVATE-STATE COMPANY**

CVRD was established in 1942 to exploit iron ore located in the Doce river region of Brazil's Minas Gerais State. It is now the country's biggest company and the world's largest iron ore exporter. Moreover, the company has diversified over the past 50 years and is now involved with the production and processing of bauxite, manganese, gold, copper, silver and woodpulp. It also runs two modern railroads some 1700 kilometers long. It has built and administers two automated marine terminals, and controls a major international shipping line.

The company is 51 per cent owned by the Brazilian Government with the remainder in the hands of private shareholders. Shares in the company are popular on the local stock exchange: between March and July 1993, CVRD shares increased some 30 per cent in dollar terms, partly because of speculation about further privatization.

The combination of State and private interests in the company has helped to foster joint ventures and associations with other companies both in Brazil and abroad. It has also ensured that CVRD invested in activities which have been beneficial to both the country and the company. For example, between 1971 and 1978 the company invested US$ 82 million in the most extensive geological survey ever undertaken in Brazil; this added over 35 new deposits to CVRD's mineral assets and helped to delineate the world's largest iron ore reserve at Carajas in the south of Para State. This latter reserve led to a new mine-railroad-port complex that absorbed investments of US$ 3 billion, came on stream in 1985 and now produces each year 35 million tons of iron ore as well as one million tons of manganese. During the last decade, CVRD has invested a further US$ 270 million in geological and technological research; as a result, many new technological, chemical and industrial processes for ore production and beneficiation have been patented in Brazil and elsewhere and are today used widely by the world mining industry.

CVRD also aims to demonstrate how economic activities may be harmonized with the preservation of the natural environment. To date the company has invested US$ 600 million in environmental programmes and intends to invest a further $ 300 million over the next 10 years. They cover: environmental control, especially of air and water quality in regions affected by CVRD projects; recovery of degraded areas, particularly through reforestation; conservation of natural forests, including protection of the areas surrounding mining sites as well as the purchase for preservation of natural forest areas; and research and development of new methods for environmental control, as well as an intensive programme of environmental education.

36. Such policies invariably lead, sooner or later, to a rise in production costs. In Zaire, for example, largely as a result of "high-grading" over the past 20 years, production costs have risen sharply from 76 cents per pound in 1988 to 140 cents per pound in 1991, while the quantity produced has fallen by half.[14] Since copper prices also fell over the period (to around US$ 1.10 in 1991), copper rents in Zaire have effectively disappeared. A similar situation

obtains for Zambia where the State enterprise, largely decapitalized, has rarely shown a profit during the 1980 decade.

37. When the revenue from mineral rent is no longer available to government, public investment, whether in the mineral sector or elsewhere in the economy, is more likely to fall below the level necessary to replace the depleting mineral asset with new productive capital. As a result, the net domestic product of the country can actually decrease and the process of sustainable development become halted or reversed. Moreover, over the longer term, the practice of decapitalization will threaten the viability of the State mineral enterprise itself.

B. Responsibility for environmental protection and social liabilities

38. Mining and the processing of minerals disturb the natural environment. The production of one ton of copper, for example, involves the movement of hundreds of tons of rock and earth; and the ratio can be much greater for the recovery of some other metals such as gold. Since the processing of minerals typically consumes a large amount of energy, many mineral industries, notably iron and steel-making and cement manufacturing, emit to the atmosphere large quantities of carbon dioxide which is the principal contributor to global warming. The recovery of copper and nickel metal from sulphide minerals generates much greater quantities of sulphur dioxide (SO_2) than of the metals themselves; atmospheric emissions of SO_2 are the major cause of "acid rain", which adversely affects agriculture, forests, aquatic habitats and the weathering of building materials. These and other impacts of mineral exploitation on the natural environment can affect human health, directly or indirectly. Some common minerals - such as lead - are themselves dangerous for humans. Society is also affected by mineral exploitation when this involves the relocation of human habitats; mining in remote, previously uninhabited areas may require the establishment of entire new townships with attendant infrastructure and social services.

39. The ownership structure of the mineral enterprise determines corporate approaches to the management of environmental and social issues; this is particularly true for those countries where environmental legislation is lacking or deficient, which is the case for many developing countries. Other factors which help to shape corporate policy are the scale of the enterprise and resource availability in terms of capital, technology and skills. A large-scale private enterprise situated in a developed country is more likely to have a well-defined and effectively managed environmental policy than a State enterprise situated in a developing country. There are various reasons; first, government legislation and enforcement measures are more elaborate in the developed country; secondly, the developed-country enterprise is more likely to have the capital, the operational autonomy and the technology that is needed to incorporate in the production process a comprehensive system for environmental protection.

40. In developing countries, the situation is often more problematic, as is illustrated by the case of Chile. The world's largest producer of primary copper, Chile undertakes extensive copper smelting activities that result in very large

atmospheric emissions of SO_2 and of particulate matter including arsenic. Emissions of SO_2 reached a peak of over 900,000 tons in 1989, at which point Chile ranked fourth - after the United States, China and the former USSR - for sulphur emissions from fixed sources. The Government has recently passed a law (decree number 185, adopted in 1992) to control emissions of sulphur and particulate matter. This law, which applies, *inter alia*, to all copper smelters in the country, sets the year 2000 as the time limit for compliance.

41. In Chile, however, some 95 per cent of total smelter capacity (five out of six smelters) is owned by the State.[15] The one privately owned smelter already complies with environmental regulations. Investment by the State enterprises (CODELCO and ENAMI) in new treatment plants and other equipment, amounting to some 500 million U.S. dollars between 1986 and 1991, has helped to reduce sulphur emissions; thus, by 1991 an overall reduction of 15 per cent had been achieved from the 1989 peak level. Nevertheless, environmental performance at the five State-owned smelters continues to be unsatisfactory, with average sulphur fixation rates ranging from as low as 2.5 per cent in one smelter to a high of 45 per cent in the best equipped smelter. Moreover, copper mine production continues to increase. The State enterprises plan to expand existing smelter capacity (the investment required to expand existing capacity is about one half of that required for the construction of a new smelter). In order to expand smelter capacity and at the same time reduce emissions to comply with decree law 185, it is estimated that the "environmental" investment at the five State smelters would need to amount to 920 million US dollars over the period 1992-1999. An important question is whether the Government will be able to provide nearly one billion dollars to ensure that the enterprises which it owns comply with the law.

42. The dilemma facing Chile is shared by a number of developing countries: what environmental goal can the State really afford? The question of opportunity cost is most problematic and always present, since in most developing countries there are a large number of worthwhile social projects competing for limited public funds. The issue is further complicated by the fact that mineral activity, however prominent in the national economy of a developing country, is rarely the main source of environmental degradation for the country as a whole. Thus, in Chile, like most developing countries, water and air pollution from urban growth and loss of agricultural land through erosion and desertification are more pressing socio-environmental problems than pollution from mining. In these circumstances, if the Government were able to set aside a substantial amount for environmental protection, it is unlikely that the first priority would be the mineral sector.

C. Is private enterprise a solution?

43. It is evident from the above observations that when mineral production is largely or wholly organized by the State special problems arise concerning economic and environmental efficiency. The participation of the State in the management of the enterprise is ambiguous: the State purports to act as an efficient commodity producer when in reality its role is a purveyor of public goods. In a State mineral enterprise the management may be effective in dealing

with day-to-day production issues but it often lacks enough financial autonomy for those capital budget decisions which are critical to the longer-term stable growth of the enterprise. The bias of the State in such decisions is almost always towards the decapitalization of the enterprise.

44. When large-scale private enterprises, including foreign-owned mining firms in developing countries, can perform better than some State enterprises, the privatization of existing State-owned enterprises might be a way to achieve sustainable mineral exploitation. However, privatization raises a complex set of issues for negotiation between the State and prospective private investors, the most important being the willingness and capacity of the parties concerned to absorb outstanding financial, social and environmental liabilities. These liabilities can be very extensive given the large size of many State mining companies.[16] Indeed, one reason for State ownership in the first place has been the lack of other agents with the capacity to raise capital on such a large scale and take on contingent liabilities.

45. The extent of financial liabilities - which can include tax arrears, accumulated losses, bank loans and bad debts - will depend on the scale and recent economic performance of the enterprise. Such liabilities are relatively easy to quantify but their negotiation is likely to be linked with the valuation of other company assets such as plant and equipment and mineral reserves. Agreement on the value of these latter assets may be difficult, especially where a State enterprise has been unable or unwilling to invest in new equipment or to undertake exploration to replace depleting mineral reseves.

46. Social and environmental liabilities, however, are likely to prove the most problematic issues for privatization. The example given above of atmospheric emissions of SO_2 in Chile serves to indicate the possible size of such environmental liabilities. Other types of environmental liability may be more difficult to quantify especially when the impact on the natural environment or on human health has not yet occurred or even been anticipated. Some of these impacts may ultimately produce very extensive liabilities, a notable example being the impact of asbestos dust on lung disease which gave rise to a liability assessed at 2,000 million U.S. dollars. Social liabilities arise in connection with the provision of housing, hospitals and schools. Large State mining enterprises in developing countries often provide such welfare facilities to employees and their families; if these facilities were not otherwise available in the country, the obligation to provide them could constitute a formidable liability for the prospective private enterprise.

47. Such issues suggest that the privatization of State mineral enterprises may not be achieved quickly. They also imply that the State may be forced to mark down considerably the value of its assets in order to compensate for the liabilities perceived by the prospective buyer; otherwise it may have to assume itself some of the inherent liabilities. In these circumstances, the State would need to assess carefully the costs involved and weigh them against the benefits of privatization.

48. In spite of the difficulties, some countries are in the process of privatising State-owned mineral enterprises or are contemplating action to this end (see box 3). The experience of such countries will provide useful pointers

for others which are contemplating privatization, and help the increasing number of Governments that are encouraging all agents engaged in mineral production to work towards sustainable development through economic and environmental efficiency.

BOX 3.

PERU: PRIVATIZATION ATTRACTS INTERNATIONAL INTEREST WITH NEW CAPITAL FOR MODERNIZATION AND ENVIRONMENTAL INVESTMENTS

Hierro Peru, the State iron ore concern, was sold in October 1992 to Shougang Corporation of China for US$ 120 million and the assumption of US$ 42 million in debt; the buyer has also pledged to invest US$ 150 million over three years in modernization. Also competing for this property was a consortium led by CAP of Chile and Mitsubishi of Japan.

Quellaveco copper deposit was sold in December 1992 for US$ 12 million to Empresa Minera de Mantos Blancos of Chile (a subsidiary of Anglo American); Mantos Blancos has pledged to invest US$ 562 million in a bio-leaching process and investment in environmental control could amount to US$ 200. This copper deposit lies close to two mines worked by Southern Peru Copper Corporation which also bid for the property.

Minpeco USA, a marketing company, was sold for US$ 4.5 million in September 1992 to Inga, a Brazilian zinc mining and refining company.

Other State enterprises that were put up for sale during 1993 were Centromin (seven mines, one smelter complex and one copper refinery) which is offered for sale as an entire unit, and Minero Peru, a group of copper, gold, silver and zinc properties that are for sale as individual units.

III. MAKING USE OF MINERAL RESOURCE INFORMATION

49. Natural resources, by definition, are not made to specifications determined by the consumer; moreover, they are not always situated where the consumer would wish them to be. For mineral resource especially, knowledge about their location may be incomplete or even lacking entirely. Consequently, some investment in information is required in order to determine the characteristics and eventual usefulness of natural resources. A difficult problem for Governments, as well as for entrepreneurs engaged in the extractive industry, is deciding how much money to spend on collecting and analysing information on natural resources. Most earth scientists would argue that more information is always better. From an economic perspective, however, expenditure on information is worthwhile only as long as the benefits that can be derived from the information exceed the costs of its acquisition.

50. The cost of acquiring mineral resource information is relatively easy to quantify. It can be quite substantial, whereas the benefits are often difficult to define and may be highly uncertain or take a long time to materialize. Perhaps for this reason, government expenditure on natural resource information, in terms of funding for geological surveys, for example, or public investment in education and research in the earth sciences, tends to have a relatively low priority. This tendency is especially evident in developing countries, where there is often a high opportunity cost for investment in resource information, in spite of the fact that the natural resource potential of these countries may be great and largely unexploited.

A. The uses of mineral resource information

51. In the context of sustainable development, mineral resource information can be used to help address more effectively a number of national and local policy issues. For all countries, resource information is an important element in drafting effective environmental legislation. It is equally valuable for the classification and efficient use of both land and marine areas. For developing countries, resource information is likely to be helpful in development planning for a number of reasons:

- In planning regional development, account is usually taken of existing infrastructure and habitats, together with resources such as soil, timber, water and, perhaps, the known mineral deposits. However, an assessment is rarely made of the undiscovered mineral resource potential of the region, in spite of the fact that in poorly explored regions, the undiscovered mineral resource are often larger than those which have been discovered. If this potential is ignored, the choices made for regional development are likely to be less than optimal. For example, new infrastructure such as roads and railways may be badly located in relation to mineral resource; this, in turn, could discourage further exploration and eventually impede the economic development of the region.

- National resource assessments provide a factual basis which can be used to make public investment and development aid more efficient. Resource assessment information can be applied in the formulation of national minerals and energy policies; the information can be particularly relevant in determining priorities for government spending on more detailed geoscience information, including geological survey, and on related human-resources development. The process of attracting foreign aid and investment, technical assistance and technology is also likely to be facilitated by the availability of reliable resource assessments.

- The design of processing facilities for minerals has to take into account the specifications of the mineral materials and, where economies of scale are important, the quantity of throughput and related transport arrangements. For this, mineral resource information can be useful in deciding on the viability and eventually the size, process specifications, and location of processing plants.

- Broad-based mineral resource assessment can point to a wide range of potential mineral commodities and thus offer an opportunity for the diversification of mineral exports for enhanced income stability. The exploitation of a wider range of minerals could also result in lesser dependence on imported raw materials and help to stimulate and diversify the domestic economy by furthering the growth of basic industries, for example, the production of building materials and simple chemicals, in order to satisfy local or regional needs.

- Environmental legislation and policies will have greater relevance and effectiveness when based on mineral resource information. For example, mineral occurrence conditions, including the *natural* levels of concentration of minerals in soils and water, differ from one area or country to another; these differing conditions need to be taken into account in regulating and determining environmental target levels for mineral concentration. For the purpose of classifying and reserving land, mineral resource information is especially necessary since this information can significantly alter the opportunity cost of various options under consideration.

52. Data gathered in the course of resource assessment or geological surveys can have applications other than mineral evaluation. Geochemical data have wide application in fields such as human, animal and plant health, and environmental baseline studies. Hydrogeological information is important where groundwater affects mining operations; the same information can also serve to ensure that excessive exploitation by over-pumping is avoided and so safeguard other industrial and social needs for water. In many developing countries, however, the relevant scientific expertise is lacking, or the data, if gathered, are not used or properly preserved.

B. Organizing mineral resource information at the country level.

53. The theory and techniques of resource assessment are envolving. For example, the study of plate tectonics has led to new geological pointers; remote sensing from satellites, new imaging and mapping techniques and computerized databases are being increasingly used. These innovations allow large amounts of information to be produced and analysed at relatively low cost. They offer low-income countries an opportunity to increase dramatically their knowledge about their natural resources. In the context of sustainable development, moreover, the value of natural resource information is now being increasingly recognized: for example, within the United Nations Environment Programme, the Global Resources Information Database has been established to support a worldwide environmental monitoring system (GEMS). Such international initiatives are helping to change perceptions at the national level about the value of natural resource information.

54. In most countries, including most developing countries, Governments provide for the collection of information on national mineral resources through a technical institution responsible for geologic surveys. The scope of activity of such institutions varies greatly from country to country. It is largely dependent on the ambition of the country and the level of regular funding by

Government (see box 4). In many developing countries, additional assistance for the collection and management of resource information is provided on an *ad hoc* basis from multilateral and bilateral sources. Comprehensive data on public expenditure for mineral resource information are lacking and, where available, often not comparable among countries. Government spending on mineral resource information seems to vary, between countries, depending on the level of national income. Countries without an established mineral sector tend to spend less on resource information per unit of land area than countries which already have a significant interest in minerals.

55. The financial resources available will influence the design of the national survey programme, the level of detail at which the survey is undertaken, including the scale and thematic content of mapping work, and the range of laboratory and technical analyses. Good laboratory work is essential as unreliable results can lead to useless expenditure on spurious follow-up work or may result in potentially important mineralization being overlooked. Efficient data storage and retrieval, and facilities for digital mapping and the relational and spatial analysis of data are also essential for natural-resource management. New technologies for data management, involving mini- and personal computers, are becoming more accessible in terms of both cost and ease of use. Some developing countries are already making use of these technologies, especially for the electronic archiving of geological maps and reports which, *inter alia*, ensures safer storage. This should be an important concern of all countries which presently store geological and other resource data in paper form, since these records, often representing an accumulated investment of many millions of dollars, are more likely to deteriorate or be destroyed than electronic records.

56. At the level of government, the situation can be aggravated by institutional rigidities and the effects of professional specialization which tend to inhibit interpersonal communication and policy dialogue. Within the structure of government, institutes for geologic survey tend to be located at some distance from the centre; their priorities and programmes of activity are primarily technical and may be largely defined internally. Policy-makers in central government, including finance and planning departments, rarely have direct contact with the geological survey institute except perhaps during the annual budget exercise; and central policy-makers may not in any case have the technical knowledge required to assess and eventually redirect the institute's programmes. In many countries, moreover, policy-makers are preoccupied with short-term crisis situations, to the detriment of longer-term resource planning.

57. Finally, few - if any - countries, developed or developing, have established the practice of recording mineral resource as capital assets in the national accounts, in spite of the fact that the United Nations System of National Accounts now provides for "satellite" accounts to record such resources as environmental assets.

BOX 4.

NATIONAL GEOLOGICAL SURVEY: CONTRASTS AND CONSTRAINTS

The quality of a national geological survey can vary considerably from one country to another. Country capacities are constrained by the extent of national land and marine areas and by the level of development and income. This is illustrated by three diverse examples:

	Australia	Chile	Sri Lanka
	----------	(thousand km²)	----------
Land area	7,713	757	66
Marine area	4,496	2,288	517
Total national area	12,209	3,045	583
	----------	(US$, 1990)	----------
GDP per capita	17,200	2,110	465
GDP per km² of total national area	24,070	9,125	13,375

In Chile, the National Survey for Geology and Mining (SERNAGEOMIN), under the Ministry of Mines, is responsible for mapping the geology of the country including marine areas. The current programme aims at covering the entire country at the scale of 1:250,000. SERNAGEOMIN supports its geological work with in-house laboratory analyses in the disciplines of chemistry, geochronology, mineral separation, fluid inclusions, X-ray, petrography and paleontology. Geological and mining information, including economic geology, is organized in an integrated system of relational databases with computerized storage and retrieval. SERNAGEOMIN has a permanent staff of around 140 persons including some 90 professionals.

In Sri Lanka, the 1992 Mines and Minerals Act established a new framework for the mining industry and provided for a Geological Survey and Mines Bureau to relate with government through the Ministry of Industries, Science and Technology. The geology of the country has been mapped in detail at 1 inch to 1 mile (approx. 1:63,360). Due to financial constraints, however, some maps have not yet been published and exist only in manuscript form. There are no mineral inventories or computerized databases. Until recently, the staff of the Survey included four geologists and two geophysicists but no geochemist, mining engineer or mineral economist; in-house laboratory facilities were minimal. Sri Lanka has an important mineral history and is deemed to have good mineral potential.

In Australia, the Bureau of Mineral Resources, Geology and Geophysics (BMR), the principal geoscientific agency of the Government, is located in the Department of Primary Industries and Energy. Expenditure on geoscience research and resource assessment, including mineral fuels, amounted to 56 million Australian dollars (approx. US$ 40 million) during fiscal year 1990-91 and involved 570 staff years. As an extension of its geological work, the BMR provides scientific advice on the natural environment to industry and the public: for example, the Rice Growers Association of Australia base their strategic planning and management decisions on a BMR model of groundwater processes; BMR offshore resource maps have been used, *inter alia*, by fishery research ships to find deep-sea trawlable ground off Western Australia.

Notes

1. Our Common Future, the World Commission on the Environment and Development, Oxford University Press, 1987, p.43.

2. This term was originally used in relation to the Netherlands to describe the effects on that country of the exploitation of petroleum and natural gas resources located in the North Sea.

3. For the period 1989-91, the shares of the different categories of primary products in world primary commodity trade were as follows: fuel minerals, 37 per cent; other minerals, 16 per cent; agricultural products, 34 per cent; animal products, 7 per cent; fishery products, 4 per cent; and forestry products 2 per cent.

4. This ignores but does not necessarily contradict the Hotelling "rule" for exhaustible resource use (see: H. Hotelling "The economics of exhaustible resources" in *Journal of Political Economy*, 1931), which relates efficient resource use to the anticipated change in the price of the resource and to the rate of interest. For an empirical investigation of this rule, covering some 13 mineral commodities over the period 1946 to 1987, see: Stephen P. Dresch "Myopia, emmetropia or hypermetropia? Competitive markets and intertemporal efficiency in the utilization of exhaustible resources" in *Resources Policy*, June 1990. Dresch finds a preponderance for deficient rather than excessive resource utilization and suggests that this could be due to incorrect forecasts of technology and of future mineral reserve discoveries.

5. Project MINDEV, which has been funded in large part by the Governments of Norway and Sweden, included three regional seminars for developing countries in Africa, Asia and America during the period 1989 to 1992. A total of 35 developing countries have been involved as well as several developed countries, international and regional organizations and the mineral industry.

6. See footnote 2.

7. For a recent analysis of the impact of Dutch Disease on a number of mineral economies, see R. Auty and A. Warhurst: "Sustainable development in mineral exporting countries". Resources Policy, March 1993.

8. See: Theodore R. Valentine "Mineral-led economic growth, drought relief, and incomes policy: income distribution in Botswana reconsidered". American Journal of Economics and Sociology, Vol. 52, No.1 (January, 1993).

9. For a comparative analysis of these two funds, see: Peter J. Smith "The politics of plenty: investing natural resource revenues in Alberta and Alaska" in *Canadian Public Policy - Analyse de Politiques*, XVII:2:139-154 (1991).

10. For an extensive analysis of this subject see Richard Auty and David Evans, "Trade and industrial policy for sustainable resource-based development: policy issues, achievements and prospects". Report prepared for UNCTAD in 1993 (forthcoming in the UNCTAD/COM series).

11. Information on corporate control is taken from a survey of mineral industry structure, undertaken for UNCTAD by the Raw Materials Group, Stockholm, Sweden, which will appear as a report in the UNCTAD/COM series.

12. It has been recently argued that there is nothing inherently inefficient in State enterprises and that the real issue is the regime under which the company operates (see: Ha-Joon Chang and Ajit Singh "Public Enterprises in Developing Countries and Economic Efficiency" in *UNCTAD Review* No.4, 1993); this analysis, however, deals with companies that operate in areas other than natural resources. In effect, the evidence for the proposition that State-owned resource industries are less efficient is for the most part impressionistic. For a review of the literature at the end of the 1980's, see: Istvan Dobozi "State mining enterprises in developing countries: a review of the literature" in *The Role of State Enterprises in the Solid Minerals Industry in Developing Countries*, United Nations, Stockholm, 1989.

13. Source: Olivier Bomsel, "The future of mining countries: new strategies or new governments?". Report prepared for UNCTAD in 1993, forthcoming in UNCTAD/COM series.

14. Olivier Bomsel, op.cit.

15. The information concerning Chile applies to the situation in 1992 and has been supplied by Gustavo Lagos,CESCO,Santiago,Chile.

16. The 25 largest companies controlling non-fuel mining output in 1989, outside of the former USSR and the socialist countries of Asia, included seven developing country governments as controlling agents (Brazil, Chile, Zaire, India, Morocco, Zambia and Peru). See: Raw Materials Group, op. cit.